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MIKE WIREMAN

DEPARTMENT OF NATURAL RESOURCES

To: ANIMAS PROJECT MINE SITE TEAM

From: Bruce Stover,

Date: February 5, 1996

DRAFT

Re: **DRAFT** GEOLOGIC SITE REPORTS

WELL, Here's what I've got for Mineral Creek sites so far. Please review and add/correct data as you see fit. I'm missing some GPS data, as I didn't do the collecting. Send edits back to me or Herron.

LONGFELLOW-KOEHLER

Location

The Longfellow-Koehler (L-K), mine area lies immediately adjacent to the east side of US hwy. 550, 400 yards south of the summit of Red Mountain Pass, at an elevation of 11,160 feet. The site is situated on privately owned patented lode mining claims at LAT. N37°53'44", LONG. W107°42'40".

The area is characterized by rugged, steep, high alpine terrain at timber line. Winters are long with snow depths averaging 440 inches, and the summer growing season is short. Average total precipitation for the past 3 years is 45 inches, 37 inches occurring as snowfall (SGC data). The mine site lies at the very headwaters of Mineral Creek watershed. A small tributary to Mineral Creek and natural pond exist on the disturbed mine site area.

There are two draining mine adits, and a vertical shaft at the L-K site, as well as two large piles of sulphide ore wastes (Map X). These metals sources, as well as potential ground water sources, contribute to extremely high metals loading in the headwaters of Mineral Creek.

Geologic Setting

Bedrock Geology

The Longfellow-Koehler site is situated across the north-western margin of the Silverton Caldera, a regionally prominent Tertiary-aged volcanic center. Caldera rocks at the Longfellow-Koehler site consist dominantly of medium to dark brown and black, thick, massive rhyodacite and dacite flows and flow breccia of the Burns Formation. In the marginal ring-faulted zone, numerous dikes and plugs of much younger quartz-latite-porphyry (qlp), have been intruded into

the flows and breccia. Although there are local variations in texture and mineralogy of the dark volcanic flows within the caldera, they are generally too localized and discontinuous to map, and are not important in an ~~areal~~ regional context.

The L-K site lies at the contact of a topographically prominent intrusive quartz-latite-porphyry plug with ring-faulted caldera flows and flow breccia at the margin of the Silverton Caldera. The intrusive body forms a nearly vertical cliff on the east side of the site, into the base of which two adits have been driven south eastward. Within and along the margins of the intrusive qlp plug are a system of altered, highly mineralized volcanic breccia pipes. These pipes and associated veins were developed by mining operations at the L-K site.

Mineralization is typical of the Red Mountain Pass District quartz-alunite epithermal deposits. Sulphide minerals found on the mine dumps include pyrite, enargite, covellite, and chalcopyrite. The deposits were mined in veins, breccia pipes, and as disseminations in wall rock, intensely altered to silica, alunite, and clays. There are essentially no buffering carbonate minerals associated with these types of deposits.

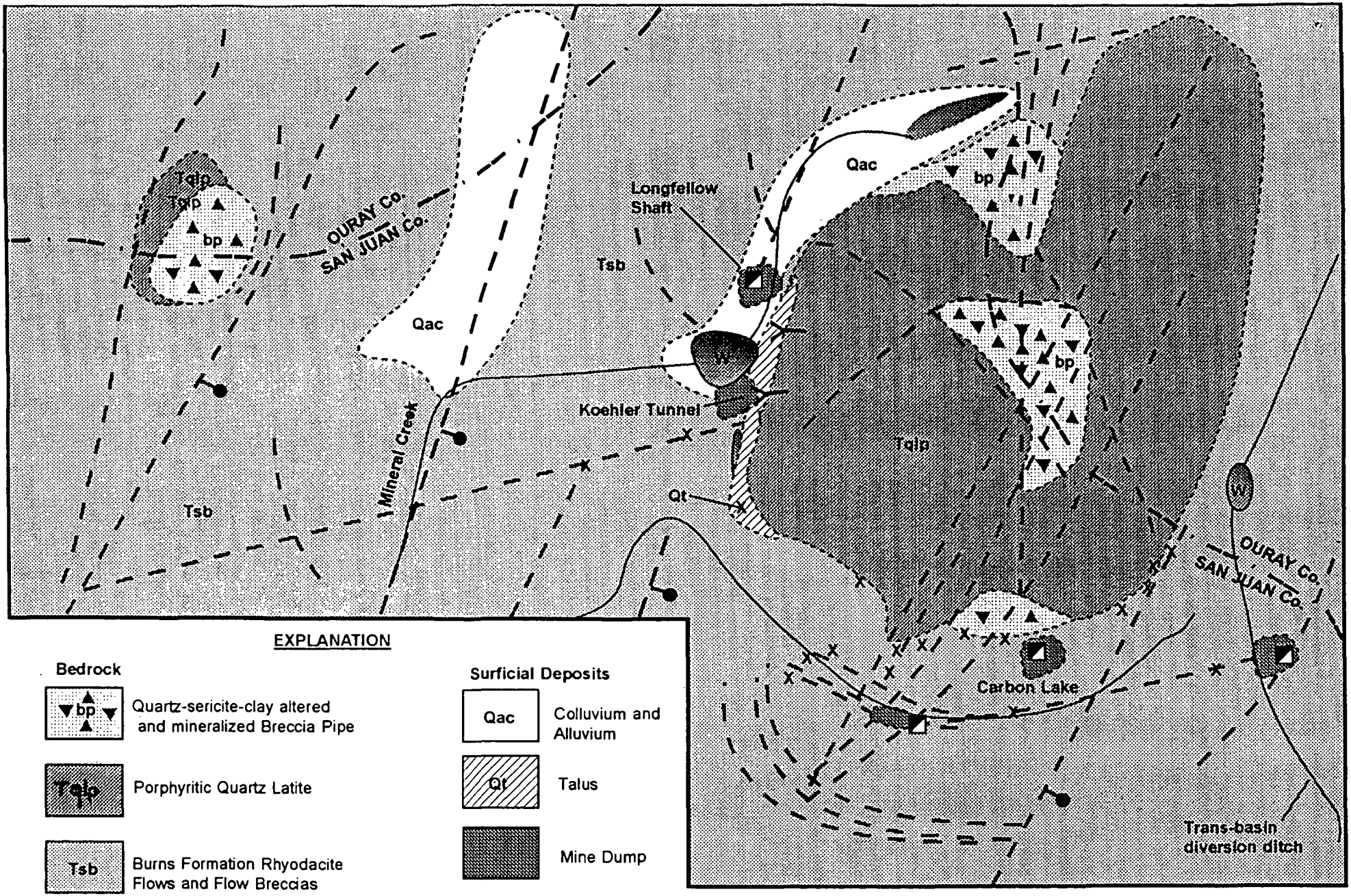
Structural Geology

Structurally, the site lies across a complex system of ring-fracture faults related to subsidence of the caldera. The faults trend north 22° east through the site, and are associated with a belt of scattered, highly mineralized altered breccia pipes. These volcanic pipes are the hosts for rich silver sulphide ore deposits known in the Red Mountain Pass district. They probably occur here because the fractured, weakened zones at the margin of the caldera allowed upward venting and movement of epithermal ore bearing fluids and gasses. The faults are generally vertical to steeply east-dipping, with the sense of movement being downward toward the center of the caldera (east side of each fault). Numerous mineralized fault and fissure veins trend parallel to sub-parallel with the ring-fracture pattern through the L-K area, most showing similar sense of displacement.

A second mineralized fault set in the L-K area trends almost perpendicularly across the dominant northeast-southwest ring-fracture pattern. One of these fault veins strikes south 76°west extending from the margin of the intrusive porphyry across the southern part of the site 200 feet south of the Koehler Tunnel portal. This fault can be traced west at the surface all the way across and beyond Mineral Creek. It appears to be acting as a preferential groundwater flow path; on the north side the water in ponds and seeps adjacent to it are visibly red, have acid pH, and high metals. Just south of the fault trace, another pond and seep appear to have normal, non-acidic waters. It is possible that contaminated groundwater from the L-K site is intercepted and conveyed over to Mineral Creek along this particular fault, and possibly others.

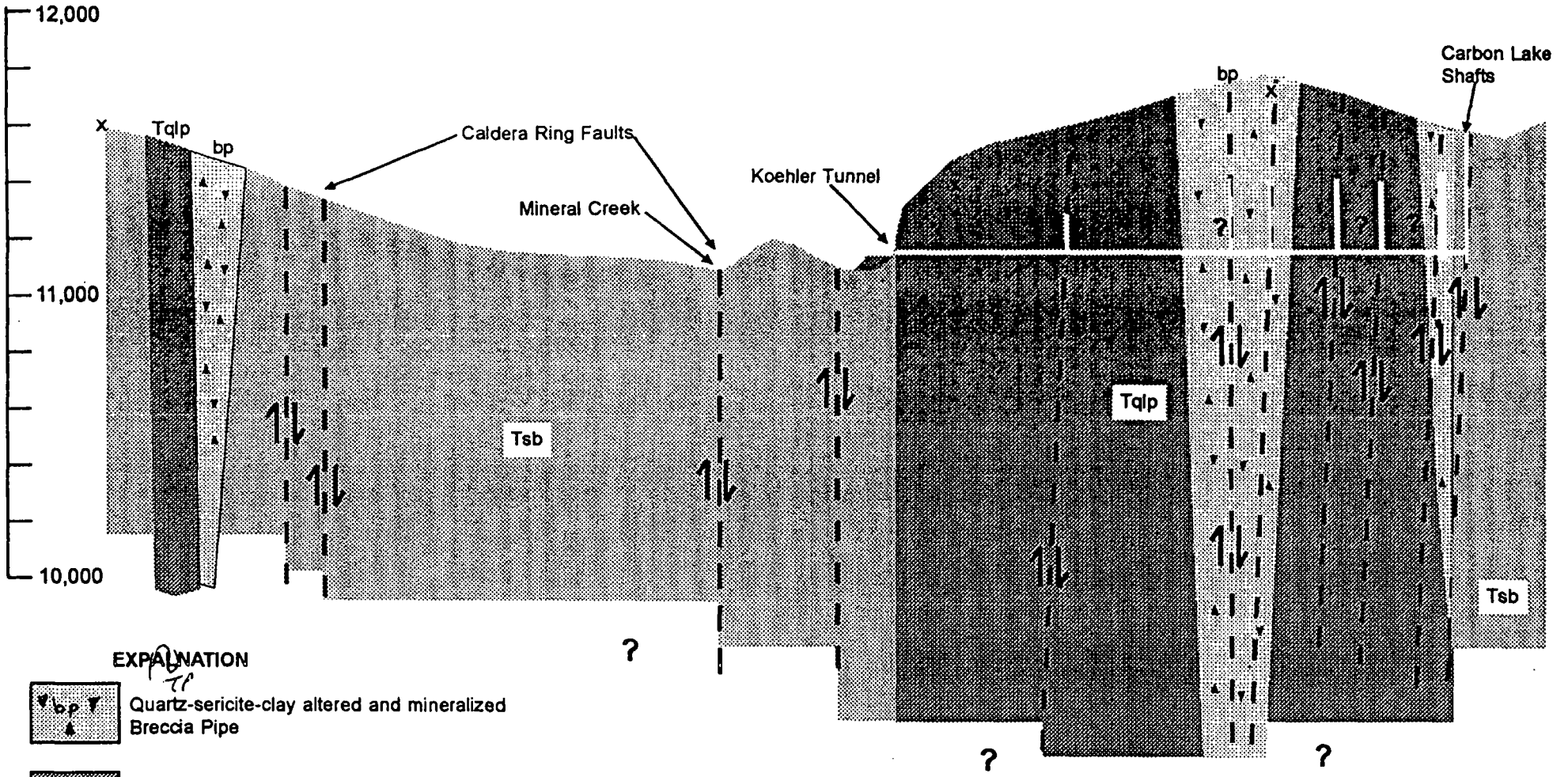
Surfical Geology

The ground surface along strike of the faults and mineralized veins forms a series of narrow valleys separated by low bedrock ridges. The L-K site is located in one of these fault-strike valleys adjacent to the intrusive plug in the ring-fault zone. Discontinuous pockets of unconsolidated pebble and cobble gravels, colluvium, and glacial till are found scattered in the narrow valleys. A small pocket of alluvial gravels lies adjacent to the Koehler Tunnel dump on the west side. Closed depressions within the valleys are occupied by ponds or wetland areas.



Geology Adapted from Burbank and Luedke, 1964
by B.K. Stover, Colo. Div. Mins. & Geol., 1996

GEOLOGIC CROSS SECTION THROUGH LONGFELLOW-KOEHLER MINE SITE, RED MOUNTAIN PASS DISTRICT, COLORADO



EXPLANATION

- bp — Quartz-sericite-clay altered and mineralized Breccia Pipe
- Tqlp — Porphyritic Quartz Latite
- Tsb — Burns Formation Rhyodacite Flows and Flow Breccias
- Mineralized Fault Vein
- Caldera Ring-Faults

500 ft 0 in

Scale 1 inch = 500 ft.

Geology Interpreted from Burbank and Luedke, 1964
by B.K. Stover, Colo. Div. Mins. & Geol., 1996

The acid pond on the L-K site was a natural pond prior to mining activity as indicated by the thick black organic soils exposed below the mine waste on the northern shore.

Talus deposits have accumulated at the base of steep cliffs around the intrusive porphyry at the L-K site. These rockfall derived deposits form extensive, thick aprons of unsorted, angular ~~angular~~ cobbles, boulders, and huge slabs of the resistant porphyry on the east side of the site, partially burying the Koehler Tunnel portal, and extending down to blanket the east shore of the pond.

Mine Workings

The volcanic caldera flows and intrusive plug at the Longfellow-Koehler site are cut by numerous mineralized faults, fissures (veins), and breccia pipe bodies which have been prospected and mined for sulphide ores. There are two draining mine adits driven east-southeast into the porphyry plug which discharge into a natural pond, and a vertical shaft developed on a northeast-trending vein. The southern adit (Koehler Tunnel) is collapsed at the portal, and covered by recent talus rock fall. The northern adit (Longfellow adit), is about 40 feet lower in elevation than the Koehler Tunnel. It is open, and the portal has been stabilized and gated. The Longfellow shaft is also intact, but has been capped.

Based on available geologic maps, and the fact that there is a limited amount of mine waste associated with the Carbon Lake glory hole and shafts, it appears the Koehler Tunnel is a cross-cut haulage tunnel driven south 74°east to access the highly mineralized Carbon Lake breccia pipe and vein complex 2,000 feet from the portal. Ore and wastes were trammed underground from this mining complex to the Koehler portal loadout. Other breccia pipe ore bodies were also intersected by the tunnel between the portal and Carbon Lake, though the extent of workings on them is unknown.

The Longfellow adit is a drift on a sulphide vein which strikes south 70°east and intersects the same breccia pipe which is cut by the Koehler Tunnel between its portal and Carbon Lake. It is not known if these two adits, 40 feet apart vertically, are interconnected via stopes or winzes in this breccia pipe.

The Longfellow shaft is sunk on a separate northeast-trending vein which may intersect another breccia pipe ore body a few hundred feet to the northeast of the shaft collar.

Mine Wastes

Approximately 20,000 cubic yards of fine to coarse sulphide mine waste exists in two separate piles on site. A mine waste pile at the Longfellow shaft contains about 5500 cubic yards while the Koehler Tunnel waste pile contains at least 14,500 cubic yards. This latter pile forms the southern shore of the pond, while the shaft pile lies upslope 170 feet away from the northern edge of the pond.

The fine grained components of the mine waste have eroded from both piles directly into the pond. This once natural pond now has a pH of 3.0 due to the influx of sulfide mine wastes and adit discharges.

Historic Structures
A headframe, hoist house, and old boiler remain as historic features at the shaft. Two old buildings are situated at the collapsed adit portal on the mine waste pile. The southern margin of this adit pile is supported by cribbing where the road to Carbon Lake squeezes through a narrow section at the toe of the pile.

There are several other shallow prospect adits only a few feet deep also on site, as well as an old wooden building just northwest of the disturbed area.

Geologic Constraints to Remediation
The Longfellow-Koehler mine site is the most geologically complex in the Mineral Creek watershed. Its position at the faulted margin of the Silverton Caldera suggests a high potential for fracture-flow groundwater-minepool interactions which might complicate potential mine drainage remediation strategies. For example, if a treatment system is contemplated to address adit discharges, it will be necessary to determine any potential groundwater loadings which leave the site, and are not seen as surface flows at the portals. A treatment system could work well on the adit discharge, but fail to meet metals removal goals in the stream due to un-identified groundwater loading sources.

Collection of the water flows from the adits for treatment could also be problematic. The fractured, jointed nature of the bedrock could be allowing seepage from the adits to enter the groundwater systems, as suggested by the numerous springs at the base of the porphyry plug. Simply sticking pipes into the portals may not suffice to collect all the water which needs to be treated. It may be necessary to re-enter the adits to some point beyond fracture influences where a grout-sealed bulkhead water-inlet can be placed to collect and prevent infiltration of tunnel flows into fractured bedrock.

Suitable soils for capping mine wastes are scarce at this site. There are some pockets of alluvial gravel and colluvium, but probably not enough to cap all the wastes. Soils in the vicinity of the pond and waste piles may be contaminated with metals, and not be suitable as cap or plant growth media. There is a lot of talus on site which may have enough smaller sized material to provide rip rap and armoring materials.

Bedrock is generally shallow, and would be difficult to excavate. There did not appear to be a suitable thickness or large enough area of unconsolidated materials in which to construct a disposal cell for the mine wastes on site. The wastes will have to be removed from the site or alternatively sterilized/stabilized insitu.

BONNER MINE

Location
The Bonner Mine area lies adjacent to the Middle Fork, Mineral Creek on the steep southern valley wall at LAT. N37°50'39", LONG. W107°44'12". Elevation across the site ranges from 10,040 ft. at the creek to 10,400 ft. at the upper mine level. The site is accessible via a jeep trail

which leads south off Ophir pass road 0.72 miles above Burro Bridge.

The site lies on a uniform, very steep mountain slope, in heavily forested alpine terrain. An active avalanche chute crosses the site on its east side.

There are 3 open and two collapsed adits at the mine. Two adits are discharging drainage across and through the two main mine dumps (Map XX).

Geologic Setting

Bedrock Geology

The Bonner site lies just west of the Silverton Caldera, a regionally prominent Tertiary-aged volcanic center. Bedrock at the surface is the San Juan Formation, which here consists dominantly of volcaniclastic, reworked, crudely bedded conglomerates, sandstones, and mudflow breccia of dark andesite and rhyodacite clasts. Geologic mapping and examination of the mine dumps indicates that the workings cut younger flows and breccia of rhyodacite and dacite of the Burns Formation in the subsurface. The Burns unit overlies the San Juan Formation, and consists of ~~flow~~ massive aphanitic and porphyritic andesite and rhyodacite volcanic ~~rock~~ flows.

Mineralized veins worked at the Bonner appeared to be related to localized light colored rhyolitic and quartz latitic rocks. Sulphide minerals found on the dump include pyrite, sphalerite, chalcopyrite, and galena in seams in the light colored vein rock. The mine lies in the zone of propylitically altered volcanic rock, (rock which has been hydrothermally altered to include one or more minerals of the assemblage calcite, chlorite, epidote), and thus there is some buffering capacity from carbonate minerals. Gangue minerals consisted of quartz, calcite, and rhodochrosite. Secondary alteration products included sodium sulfate salts, limonite, goethite, and pyrolusite coatings. Scree and talus are locally strongly cemented by iron oxides, forming ferricrete deposits on and at the base of the valley slope.

Structural Geology

Structurally, the Bonner site lies at the western edge of the caldera. Prominent graben-like ring-faults at the caldera margin lie 1,500 feet west of the site. The faults strike due north across the mouth of the Middle Fork valley, and are vertical to steeply east-dipping, with the sense of movement being downward toward the center of the caldera (east). Numerous mineralized fault and fissure veins trend parallel to sub-parallel with the ring-fracture pattern through the Bonner area, most showing similar sense of displacement.

Surfical Geology

Slopes at the Bonner site are steep. Talus, scree, and colluvium cover much of the surface, becoming thicker at the foot of the valley wall. Much of the colluvium and scree have been cemented by iron oxides, forming resistant ferricrete deposits. There are three springs just below the access road near the lowest adit level, and several more along the creek banks which appear to be draining metals laden water. The lower adit is portaled in an iron rich-conglomeratic ferricrete.

Alluvial gravels are present along the creek at the north end of the site under and adjacent to

the lower mine dump. There are also limited areas of dark black wetland soils along the creek.

The avalanche danger at this site is moderate; an active chute which has run in the recent past crosses the upper main mine dump, ~~where it encroaches into the steep chute on the east side of the site~~. At this time the chute does not extend above timberline, and does not have a large source area. Avalanches are thus confined, and consist of only the snow which falls in the chute itself.

Mine Features

The volcanic conglomerates, breccia, and tuff are cut by numerous mineralized faults and fissure veins. One of these veins was prospected and mined for sulphide ores at the Bonner mine. There are several adit levels drifting on a vein which strikes N15°E and dips steeply east, as follows:

Elev.10,120	Lower adit, open, discharges across a mine dump which contains perhaps 4,500 cubic yards of material adjacent to Middle Fork Mineral Creek.
Elev. 10,220	Middle adit 200 (100) feet higher, collapsed, also discharging. This adit is situated in the middle of a large, narrow, steep mine dump complex developed from it and adits above, which partially occupies the avalanche gully. Due to the steepness of the slopes it is difficult to accurately estimate the volume of mine waste, but the main dump complex is thought to contain on the order of 20,000 cubic yards.
Elev. 10,305	Upper adit 80 feet higher, collapsed at portal, no discharge.
Elev. 10,365	Open prospect adit 60 feet higher, no discharge, small dump.
Elev. 10,415	Open prospect adit 50 feet higher and to west of other adits in forest, no drainage, small dump.

Structures

There are several other shallow prospect adits only a few feet deep also on site, as well as a collapsed log cabin structure west of the lowest main adit.

Geologic Constraints to Remediation

The Bonner mine is constrained mainly by extremely steep slopes,and somewhat poor access. There is also an avalanche hazard associated with the steep chute crossing the site. Heavy timber around the margin of the site limits its size and access possibilities. The only bit of relatively gentle slopes lies along the creek below the lowest adit level.

Collection of the water flows from the adits for treatment could ~~also~~ be problematic. The buried colluvium-bedrock contact, and potential high permeability of the volcaniclastic conglomerates. ~~These~~ could be allowing seepage from the adits to enter near surface groundwater pathways, suggested by the numerous springs at the base of the mine site area. Simply sticking pipes into the portals may not suffice to collect all the water which needs to be

treated; it may be necessary to re-enter the adits to some point beyond the colluvial-bedrock contact where a grout-sealed bulkhead water-inlet can be placed to collect and prevent infiltration of adit flows into the surfical deposits.

Bedrock is somewhat shallow, but would be fairly easy to excavate. There did not appear to be a suitable thickness or large enough area of unconsolidated materials on appropriate slopes in which to construct a disposal cell for the mine wastes on site. The wastes will have to be moved from the site or alternatively regraded and/or sterilized/stabilized insitu if they constitute a metals loading problem.

RUBY TRUST

Location

The Ruby Trust mine adit lies on the Middle Fork, Mineral Creek on the steep northern valley wall at LAT. N37°50'xx", LONG. W107°44'xx", adjacent to the Ophir Pass road 1.7 miles above Burro Bridge. Elevation of the portal is 10,500 ft. The site is accessible via a short jeep trail which leads off Ophir pass road.

The mine site lies on a uniform, very steep mountain slope, in open sub alpine terrain. Active avalanche chutes exist adjacent to the site.

There is one collapsed adit with over 1.5 cfs discharging across and through a large dump (Map XXX).

Geologic Setting

Bedrock Geology

The Ruby Trust adit lies west of the Silverton Caldera, a regionally prominent Tertiary-aged volcanic center. Bedrock at the site is the San Juan Formation, which here consists dominantly of volcaniclastic, reworked, crudely bedded conglomerates, sandstones, and mudflow breccia of dark andesite and rhyodacite clasts. The workings may intersect rhyodacite flows and breccia of the Burns formation in the subsurface, but this could not be confirmed from examination of the dump materials.

Mineralized veins worked at the Ruby Trust appear to be related to mineralized fissures in the volcaniclastic rocks. Sulphide minerals found on the dump include pyrite and minor sphalerite, however, the dump is mainly waste country rock and does not contain a large proportion of sulphide minerals. Mineralized veins appear related to localized light colored rhyolitic and quartz latitic rocks. The mine lies in the zone of propylitically altered volcanic rock, so there is some buffering capacity from carbonate minerals. Gangue minerals consisted of quartz, calcite, and rhodochrosite.

Structural Geology

Structurally, the Ruby Trust site lies 1.5 miles west of the faulted margin of the Silverton Caldera. The marginal faults strike due north across the mouth of the Middle Fork valley, and are

vertical to steeply east-dipping, with the sense of movement being downward toward the center of the caldera (east). Numerous mineralized fault and fissure veins trend parallel to sub-parallel with the ring-fracture pattern through the Ruby Trust area, most showing similar sense of displacement.

The contact between the overlying Burns formation volcanic flows and the older San Juan volcaniclastics is close to the site of the adit, and may have been intersected by the workings. This unconformable contact could be a major groundwater conduit, which would explain the high flows of near neutral pH water discharging from the workings. It is also possible that a major water-bearing fault zone was intersected which resulted in flooding and abandonment of the operation.

Surfical Geology

Slopes at the Ruby Trust are steep. Scree, glacial drift, and colluvium cover much of the surface, becoming thicker at the foot of the valley wall. Large glacially deposited, rounded to sub-rounded boulders, as well as angular rock-fall-derived boulders from the peaks above are present on site. The adit is portaled in unconsolidated gravelly colluvium and glacial deposits, which have collapsed and sealed the workings. ~~Springs~~ water flow issue from the collapsed material about 12 feet above the adit level, suggesting there is a large pool behind the blockage at the portal.

Alluvial gravels are present along the creek at the south end of the site downslope from the mine dump. There are also limited areas of dark black wetland soils along the creek.

The avalanche danger at this site is high; two active chutes run on either side, and the open slope aspect is conducive to avalanches.

Mine Features

The volcanic conglomerates, breccia, and flows are cut by numerous mineralized faults and fissure veins in this area. One of these veins was prospected and mined for sulphide ores at Ruby Trust site. There is one adit level driven northerly into the valley wall. Judging from the size of the mine dump which is estimated to have been on the order of 10,000 cu.yds., (their) are several thousand feet of workings in the valley wall. There do not appear to be any other openings to this mine, and the lack of any strong sulphide ores or minerals on the dump seem to confirm old reports that it may have been a stock scam operation. Miners may have intersected a large water bearing zone which caused them to eventually abandon the work.

There may have been a sudden blow-out from this adit in the past. The central section of the mine dump appears to have been rapidly eroded and washed out in a sudden outburst, perhaps caused when a roof fall or blockage in the adit created significant head of water pressure which was released suddenly. The washed-out dump material lies below the toe of the pile in an alluvial fan-like deposit. The remaining dump, not including washed out material, is estimated to contain between 5,000 to 6,000 cubic yards.

Structures

There is an old collapsed loadout and the remains of a steam boiler at the site.

Geologic Constraints to Remediation
The Ruby Trust mine is constrained mainly by steep slopes, and associated high avalanche hazard. There is a fairly thick blanket of unconsolidated ~~and~~ colluvium and glacial deposits on site with which to construct settling pond embankments, although these materials contain a lot of boulders and cobbles.

Paradise Basin Unknown Mine, AKA (WHITE DEATH)

Location
An unnamed series of portals informally nicknamed the "White Death" site is located on the Middle Fork, Mineral Creek, at its confluence with the Crystal Lake tributary, LAT. N37°50'34", LONG. W107°45'50". Elevation at site is 10,640 ft. The site is accessible only via a cross country hike down steep mountain slopes, south from the Ophir Pass road, or bushwhacking up the creek bed from the Ruby Trust site downstream. The site lies at creek level below uniform, very steep mountain slopes. The site lies in an active avalanche run out zone, with at least 4 individual chutes impinging on it.

There are 4 collapsed draining adits at the site. One adit is discharging roughly 400 gpm of high-aluminum water across a small mine dump, which is heavily coated with white chalky aluminum-hydroxide precipitates. (Map XXxx).
Y → sulfate

Geologic Setting

Bedrock Geology
The White Death site lies west of the Silverton Caldera, a regionally prominent Tertiary-aged volcanic center. Bedrock at the surface is the San Juan Formation, which here consists dominantly of volcaniclastic, reworked, crudely bedded conglomerates, sandstones, and mudflow breccia of dark aphanitic andesite and rhyodacite clasts. The Contact of this unit with the overlying Burns formation runs through the site. The Burns Formation consists of massive flows of aphanitic and porphyritic andesite and rhyodacite volcanic rock. An outcrop on site reveals a crude layering of these flows, striking N50°W, dipping 10°north.

Mineralized veins worked at the site appeared to be related to localized fissures. Sulphide minerals found on the dump include pyrite, sphalerite, and some minor galena in light colored vein rock. One of these pyritic veins outcrops on the north side of the creek, and was drifted on by a short prospect adit. This vein strikes N80°W, dipping 85°north. Gangue minerals consisted of quartz, calcite, and minor rhodochrosite.

Structural Geology
Structurally, the White Death site lies 2 miles west of the margin of the Silverton Caldera, on the contact of the Burns and San Juan formations. Numerous,steeply dipping mineralized fault and fissure veins trend roughly north-south through the area, parallel to sub-parallel with the dominant ring-fracture pattern on the margin of the caldera. Cross-fissures at roughly right angles to the north-south are also common, though less persistent. The exposed vein prospected on the north side of the creek belongs to this set of fractures .

Surfical Geology
Slopes at the White Death site are extremely steep, at about 40% grade. Talus, scree, and colluvium cover much of the surface, becoming thicker at the foot of the valley wall. Much of the colluvium and scree have been cemented by iron oxides, forming resistant ferricrete deposits. A thick mantle of unconsolidated, bouldery glacial till and colluvium rests on bedrock west of the creek confluence with the stream from Crystal Lake. Within the base of this deposit is a natural ferricrete cemented zone perhaps 2.5 to 3 feet thick, developed in the colluvium and glacial materials.

There are three springs upstream from P4 adit which appear to be draining metals laden water. Thin cobbly alluvial gravels lie along the stream bed, but bedrock outcrops are common. Four active avalanche chutes dump directly into the site, including the stream bed itself which leads avalanches down from Paradise Basin. There are piles of rocky debris and tree trunks and limbs scattered over the site by avalanche activity.

Mine Features
Four prospect adits present at the site have been designated as follows:

P1-Elev.10,640 — Principal (White Death) adit on south side of creek at confluence; collapsed at portal, discharges approximately 400 gpm across a small mine dump which contains less than 700 cubic yards of material adjacent to Middle Fork Mineral Creek. Heavy white precipitates cover most of the material in the dump.

P2-Elev. 10,680 — Small collapsed prospect adit 200 feet upstream from P1 on same side of creek; discharging relatively small flow of ferruginous water, orange and red precipitates, small remaining dump, most of which has been washed away by stream flows and avalanches.

P3-Elev. 10,700 — Collapsed prospect adit across creek on north side, 300 feet upstream from P2; small acidic discharge, almost no mine dump remaining as most has been washed away during high flows. Portalled in Burns formation rocks.

P4-Elev. 10,740 — Collapsed prospect adit driven on pyrite vein striking N80°W, dipping 85°north, discharging ~70 gpm of acidic water down rock face into stream, dump totally washed away, old rails sticking out of portal.

Based on the limited site access (no improved road or trail) and small size of the dump at White Death, these mines are considered prospects that probably had little if any production. The P1 adit is probably not more than a few hundred feet in length; the tremendous discharge associated with such minimal underground extent is thus unusual.

The P1 adit is driven S22°E at or just below the unconformable, irregular contact between two extensive volcanic formations. It appears that while prospecting a vein at or near this contact, the miners broke into a tremendous natural water-bearing zone, possibly associated with a paleo-channel along the top of the underlying San Juan formation at the contact. Alternatively,

the water inflow could be associated with a major hydrothermally-altered fault or fracture system. High aluminum content could be the result of alunite-clay alteration products associated with intense alteration of ~~fault or~~ minerals along high-flow subsurface water courses. Striking such a flow probably caused immediate abandonment of the property.

Structures
There is nothing remaining at the site except a few sections of mine rail hanging out of P4. A modern corner for an unpatented claim was found at the site. The marker is a steel fence post with engraved aluminum tag, set on the nose of ground above and between the creek confluences. It is marked:

> DISC MC#139 LOC 8/23/1978
> SURVEY BY OWENS SURVEYING OUTFIT

This unpatented claim will need to be researched to see if it is still valid, and if any additional geologic information was submitted when it was filed.

Geologic Constraints to Remediation
The White Death site is severely constrained by extreme avalanche hazard, steep slopes, and poor site access. There is no good alternative way to reach the site short of creating a major disturbance by building an expensive new access road up the valley floor. No structures such as settling ponds or treatment wetlands can be expected to last long due to constant pounding by avalanches and spring flooding.

An alternative to treatment may be to seal the P1 portal and return the hydrologic system to pre-disturbance conditions. This may be possible due to the relatively minimal mine workings, and simple geology. It would involve drilling into the collapsed portal and installing a temporary pipe drain, then either:

> A) re-opening the portal and constructing a water-tight, conventional grouted bulkhead. This would probably require surface access for equipment.
>
> B) drilling and grouting the adit from the surface with out re-opening the portal, using existing water-control grouting techniques, such as used in mining and dam construction practice. This could be done with helicopter-supported mobile equipment, and would not require an access road.

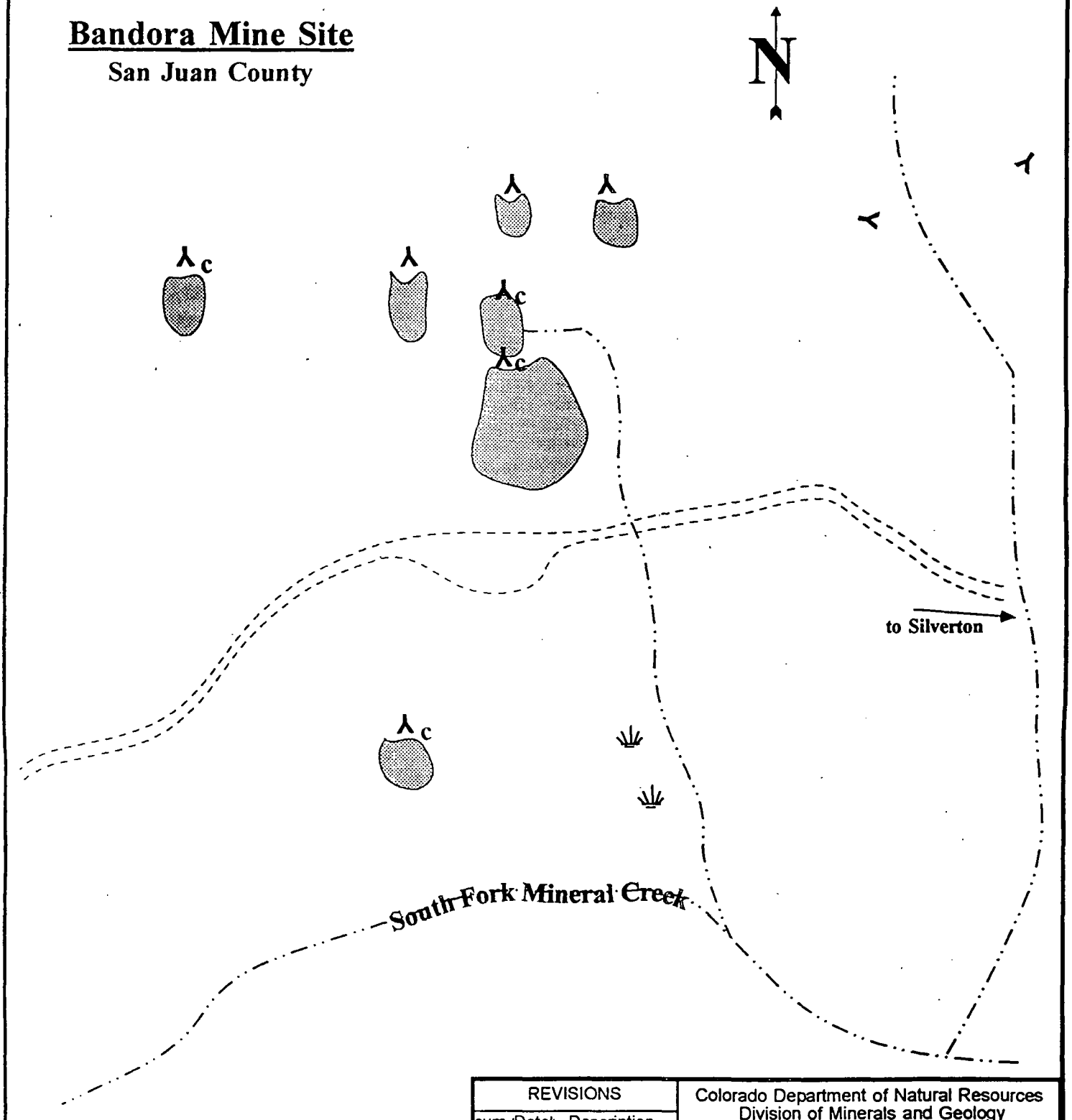
Although expensive, these approaches should result in a permanent one-time fix, and avoid having to try and maintain a treatment system in such a severe avalanche run-out zone.

BANDORA MINE

Location
The Bandora Mine lies on the South Fork, Mineral Creek 2.2 miles above the South Mineral Campground at LAT. N37°20'59", LONG. W108°34'28". Elevation ranges from 10,690 ft. to

Bandora Mine Site

San Juan County



REVISIONS			Colorado Department of Natural Resources Division of Minerals and Geology **Inactive Mine Reclamation Program**		
sym.	Date	Description	**BANDORA MINE** Site Map		
Drawn_PK_Date_2/15					
Checked_____Date____			Scale nts	Date 2/15/96	Sheet No. 1 of 1

11,000 ft. at the upper mine level. The site is accessible via the jeep road up the South Fork, Mineral Creek.

The mine is situated on a uniform, very steep mountain slope, in forested alpine terrain just below timberline. An active avalanche chute borders the mine on its east side.

There are one open and three collapsed adits at the mine. The lower most main adit is discharging drainage, which flows around the main mine dump, and on to the creek (Map XX). Fixed

Geologic Setting

Bedrock Geology

The Bandora Mine lies west of the Silverton Caldera, near the western margin of the San Juan Volcanic field. The mine workings are driven into the Cretaceous Dakota group sedimentary rocks, consisting of sandstones and shales which have been exposed beneath the overlying Tertiary volcanic sequences by down cutting of the South Fork valley through the margin of the volcanics. Cretaceous strata here strike S57°W, dip 18°N, and have been intruded and contact-metamorphosed into hornfelsic, slaty-shales and sandstones by the adjacent Rolling Mountain stock, a large intrusive porphyry body of Oligocene age. Dump materials suggest this intrusive was cut by the Bandora mine workings in the subsurface, though the surface contact lies ~500 ft. south west of the mine portal.

The basal Telluride Conglomerate unconformably overlies the Cretaceous section just above the upper most portal level, and is in turn overlain by the San Juan Formation Volcaniclastic sequence. Numerous natural springs with relatively high flows were evident at the base of the Telluride Conglomerate unit at its contact with the Cretaceous strata in the steep gully adjacent to the site on the north east.

The Hornfelsic strata at the mine site was apparently cut by mineralized fissure veins associated with intrusion of the porphyry. These veins, as well as mineralized zones along the contact of the intrusive and sedimentary strata, were developed by the Bandora Mine. Sulphide minerals found on the dump include disseminated pyrite, minor sphalerite, and very minor galena. Gangue minerals consisted of quartz, calcite, and disseminated pyrite in blocky weathering hornfelsic shale and sandstone.

Surfical Geology

Slopes at the Bandora are steep. Talus, scree, and thin colluvium cover some of the surface, but the site is dominated by rock outcrop.

A large debris-flow fan deposit lies just below and northeast of the portal area. This thick, extensive sub-angular bouldery, cobble- gravel fan complex is derived from repeated flows and rockfall from the steep gulches draining off Fuller Peak and its east ridge. Large rockfall boulders rest within and on the surface of the fan, which extends down valley from the site for 0.5 miles. Debris flows occur frequently each spring along the gulch which bounds the mine site on the northeast, delivering ever more coarse sediment to the foot slopes of the valley wall Alluvial gravels are present along the creek at the east side of the site. There are also extensive

wetlands along the creek below the mine site.

The avalanche danger at this site is minimal; an active chute runs in the steep ravine on the northeast edge of the site, but the mine itself is outside any avalanche zone.

Mine Features
The Bandora Mine consists of several adit levels driven northwest into the valley wall as follows:

Elev.10,780	Lower main adit, collapsed, discharges around mine dump which contains perhaps 3,500 cubic yards of material.
Elev. 10,880	Middle adit 100 feet higher, collapsed, also seeping drainage into mine dump. Due to the steepness of the slopes it is difficult to accurately estimate the volume of mine waste, but the dump is thought to contain on the order of 2,000 cubic yards. above the lower adit.
Elev. 10,990	Upper adit 110 feet higher, collapsed at portal, no discharge, small mine dump.
Elev. 11,000	Open prospect adit 40 ft. deep in side wall of steep ravine, no discharge, dump washed away.

Structures
There are several other shallow prospect adits only a few feet deep on site, as well as a loadout foundation wall. No other structures exist(*****????is this true...JTH-PPK).

Geologic Constraints to Remediation
The Bandora site has minimal geologic constraints. Access is relatively good due to the jeep road running up the valley. The site is not impacted by active avalanche chutes. A large amount of unconsolidated cover material exists on site in the debris fan deposits. These fan gravels contain large cobbles and boulders, but should be easily excavated with conventional equipment.

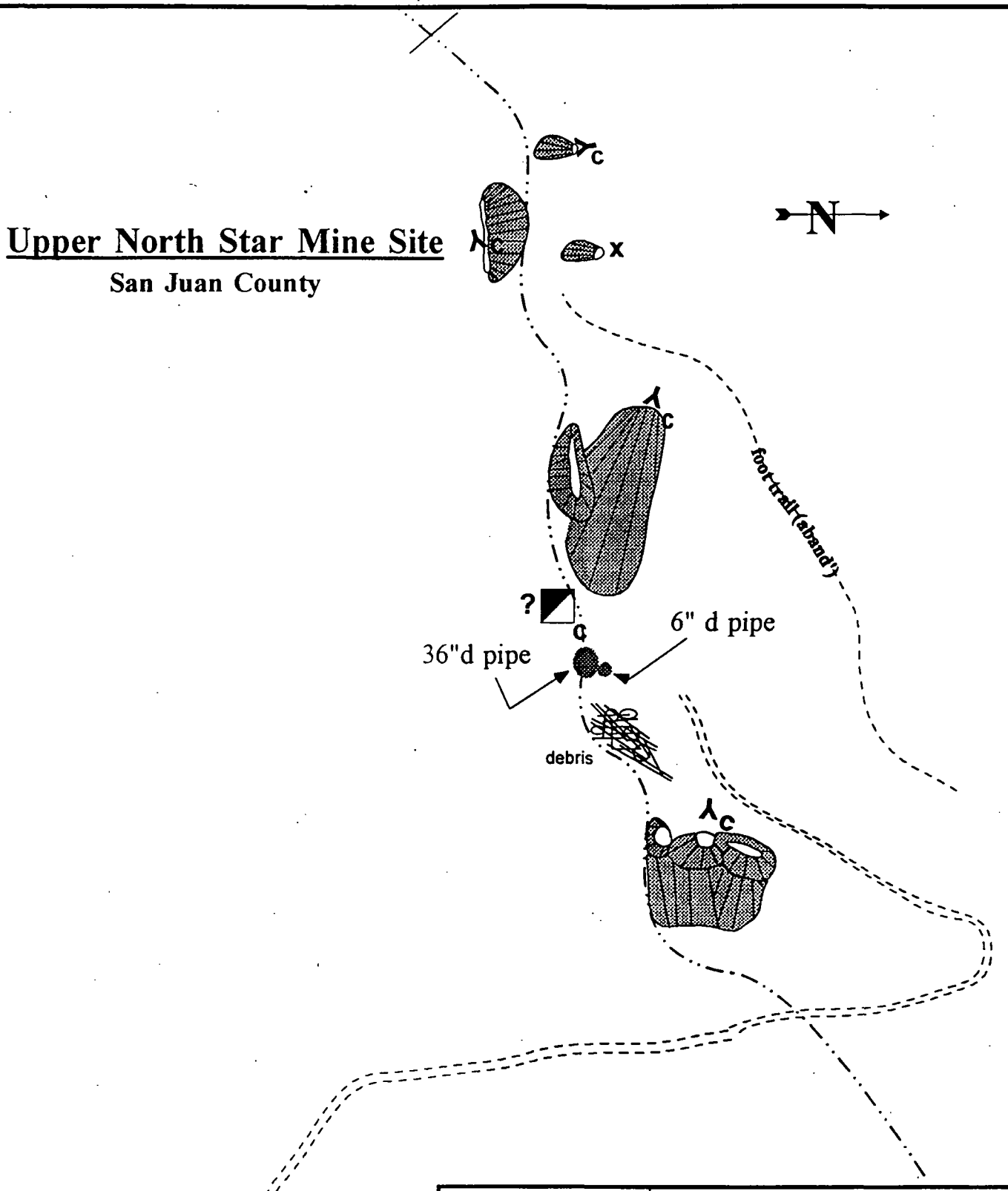
Collection of the water flows from the adits for treatment could be problematic. The fractured, jointed nature of the rock could be allowing some seepage from the adits to enter near surface groundwater pathways, suggested by the springs at the base of the slopes.

NORTH STAR MINE

Location
The North Star Mine is adjacent to Mineral Creek 3/4 mile above its confluence with the Animas River at Silverton. The site lies at the northern foot of Sultan Mountain at LAT.

Upper North Star Mine Site

San Juan County



to lower North Star Mine,
U.S. 550

REVISIONS		
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Checked_____Date____		

Colorado Department of Natural Resources
Division of Minerals and Geology
Inactive Mine Reclamation Program

UPPER NORTH STAR SITE MAP

San Juan County

Scale	Date	Sheet No.
nts	2/16/96	1 of 1

DRAFT

missing data

N37°**'**", LONG. W107°**'**". Elevation at the site is 9,400 ft. It is accessible directly from U.S. Hwy 550.

There are 2 collapsed adits at the mine. The lower main mill-level adit is discharging 300 gpm through a drainage pipe, then down a lined channel directly into the Creek. A large mine dump is situated in the flood plain of the Mineral Creek (Map XX).

Geologic Setting

Bedrock Geology

The North Star site lies on the southern margin of the Silverton Caldera, a regionally prominent Tertiary-aged volcanic center. Workings were driven southwesterly into a locally extensive porphyritic intrusive quartz monzonite of Oligocene age. This intrusive body of rock lies along the southern margin of the caldera, extending south to comprise Sultan Mountain. The intrusive body is separated from massive rhyodacite caldera flows and breccia on the north side of Mineral Creek by a graben-like ring-fault system beneath the valley floor.

Numerous mineralized fault and fissure veins trend parallel to sub-parallel with the ring-fracture pattern through Sultan Mountain, most showing similar sense of displacement. Sulphide minerals found on the dump include pyrite, sphalerite, chalcopyrite, and galena. There is little alteration of the country rock here, and therefore limited buffering carbonate minerals are present in the gangue. Gangue minerals consisted ~~of~~ mostly quartz, with very minor calcite and rhodochrosite.

Structural Geology

Structurally, the North Star site lies at the southern margin of the Silverton Caldera. Prominent graben-like ring-faults at the caldera margin lie ~~beneath~~ adjacent to the North Star site. The faults strike northwest-southeast along the base of Sultan Mountain. Mineral Creek runs along the ring-fault structure, defining the southern boundary of the caldera. The faults are vertical to steeply north-dipping, with the sense of movement being downward toward the center of the caldera (north). Numerous mineralized fault and fissure veins trend parallel to sub-parallel with the ring-fracture pattern through the North Star area, most showing similar sense of displacement.

Surfical Geology

The North Star site is mantled with thick glacial drift. The till is an unsorted, ~~homogeneous~~ unstratified deposit of large boulders, cobbles, and gravel-sized clasts in a gray silty-clay matrix. The deposits are quite extensive, extending upslope 1000 feet from the creek bed, and may be up to 50 feet thick along the lower foot slopes of Sultan Mountain. Talus, scree, and colluvium cover much of the slopes above the glacial deposits.

A large, active debris-fan bounds the mine site on the west at the mouth of the steep ravine on the north side of Sultan Mountain. The deposit consists of large boulders, cobbles and gravels deposited by debris flow and avalanche activity. The ravine is also an active avalanche chute, but does not directly affect the mine site.

Alluvial gravels are present along the creek at the north end of the site under and adjacent to the large mine dump, which partially blocks the present active stream channel of Mineral Creek.

Mine Features
There are two main adit levels as follows:

Elev.9,385	Main lower haulage adit, ~~collapsed~~ sealed, discharges ~300 gpm into a lined ditch, directly into Mineral Creek. Large mine dump estimated at 40,000 cubic yards.
Elev. 9,520	Upper adit, collapsed, no discharge, moderate sized dump thought to contain on the order of 3,500 cubic yards.

There are also several collapsed portals high up in the ravine, and reportedly a collapsed stope which crosses the ravine and is intercepting and diverting surface water into the mine workings. These mine features are 500 feet vertically above the main adit level at around the 9,800 ft elevation.

Structures
There are several mine buildings which remain at the site. A permitted prospecting operation was conducted at this mine in the recent past, and several of the buildings are modern, and in good condition. ~~A collapsed load-out exists on the northeast edge of the historic waste pile adjacent to the creek.~~

Geologic Constraints to Remediation
The North Star mine is constrained by the flood plain of Mineral Creek, and the steep debris-flow, avalanche chute associated with the steep ravine on the west side of the site. This ravine does not directly affect the main mine site, but does encompass the reported collapsed stope, and access to it. Jeep access is possible to within 100yds of the stope. eqmp. access

Bedrock is deep, mantled with a thick deposit of bouldery glacial till. There are ample areas of suitably thick unconsolidated till on site to provide plenty of capping soils materials for the waste piles. Large boulders are also present in the till for armoring the toe of the waste pile along the creek.

CARBON LAKE

Location
The Carbon Lake mine area lies ½mile east of US hwy. 550 near the top of Red Mountain Pass in San Juan County, at an elevation of 11,500 feet. The site is situated on privately owned patented lode mining claims at LAT. N37°53'45", LONG. W107°42'20".

The area is characterized by rugged, steep, high alpine terrain at timber line. Winters are long with snow depths averaging 440 inches, and the summer growing season is short. Average total precipitation for the past 3 years is 45 inches, 37 inches occurring as snowfall (SGC data). The mine site lies at the very headwaters of Mineral Creek watershed. A small first-order tributary

to Mineral creek drains the mine area.

There are several collapsed shafts and a glory-hole feature at the Carbon Lake site, as well as three piles of sulphide ore wastes (Map X). The eastern pile is separated from the Mineral Creek headwaters by a trans-basin diversion ditch which collects run off from it and conducts it north into the Red Mountain Creek drainage. These metals sources, as well as potential ground water sources associated with the underground mine workings, have contributed to extremely high metals loading to the headwaters of Mineral Creek.

Geologic Setting

Bedrock Geology

The Carbon Lake site is situated just inside the northwestern margin of the Silverton Caldera, a regionally prominent Tertiary-aged volcanic center. Caldera rocks at the Carbon Lake site consist dominantly of medium to dark brown and black, thick, massive rhyodacite and dacite flows and flow breccia of the Burns Formation. In this marginal ring-faulted zone, numerous dikes and plugs of much younger quartz-latite-porphyry (qlp), have been intruded into the flows and breccia. Although there are local variations in texture and mineralogy of the dark volcanic flows within the caldera, they are generally too localized and discontinuous to map, and are not important in an ~~areal~~ regional context.

The Carbon Lake site lies at the contact of a topographically prominent intrusive quartz-latite-porphyry plug with ring-faulted caldera flows and flow breccia at the margin of the Silverton Caldera. The intrusive body is elliptical in plan, 2,000 feet wide and 3,500 feet long, oriented parallel to the caldera margin. It forms a steep, prominent topographic high on the west side of the site. Within and along the margins of the intrusive plug are a system of altered, highly mineralized volcanic breccia pipes and mineralized faults. These pipes and associated veins were developed by vertical shafts at the Carbon Lake site.

Mineralization is typical of the Red Mountain Pass District quartz-alunite epithermal deposits. Sulphide minerals found on the mine dumps include pyrite, enargite, covellite, and chalcopyrite. The deposits were mined in veins, breccia pipes, and as disseminations in wall rock, intensely altered to silica, alunite, and clays. There are essentially no buffering carbonate minerals associated with these types of deposits.

Structural Geology

Structurally, the site lies just east of a complex system of ring-fracture faults related to subsidence of the caldera. The faults trend north 22°east, and are associated with a belt of scattered, highly mineralized altered breccia pipes. These volcanic pipes are the hosts for rich silver sulphide ore deposits known in the Red Mountain Pass district. They probably occur here because the fractured, weakened zones at the margin of the caldera allowed upward venting and movement of ore bearing fluids and gasses. The faults are generally vertical to steeply east-dipping, with the sense of movement being downward toward the center of the caldera (east side of each fault).

Numerous mineralized fault and fissure veins trend parallel to sub-parallel with the ring-fracture pattern through the Carbon Lake area, most showing similar sense of displacement. Slickensides exposed in a silicified, brecciated fault zone strike N30°E, dipping 67°east.

A second mineralized fault set at Carbon Lake trends along the small stream draining the site, forming the creek bed and banks. These fault veins strike almost due east-west, but curve northwards at their ends, mirroring the contact of the elliptical porphyry plug. It is likely that contaminated water from the Carbon Lake site is intercepted and conveyed to the groundwater system along these faults in the stream bed.

Surfical Geology

There are almost no surficial deposits at the Carbon Lake site. Nearly every where, volcanic bedrock is at or just beneath the surface. Thin, patchy colluvium lies on some of the gentler slopes, and on the foot slopes around the porphyry plug. Natural wetlands existed along the small stream in the mine area, but vegetation was killed by runoff from waste piles, and the thin soils have subsequently been partially eroded. There is not enough suitable unconsolidated material on-site for revegetation or capping work.

Mine Workings

The volcanic caldera flows and intrusive porphyry at the Carbon Lake site are cut by numerous mineralized faults, fissures (veins), and breccia pipe bodies which have been prospected and mined for sulphide ores. There are two mine shafts sunk on a breccia pipe vein complex, but very little dump materials are evident. Apparently the southern adit (Koehler Tunnel) at the Longfellow Koehler site west of Carbon Lake is the main access for the Carbon Lake workings. It appears the Koehler Tunnel is a cross-cut haulage tunnel driven south 74°east to access the highly mineralized Carbon Lake breccia pipe and vein complex 2,000 feet from the portal. Ore and wastes were trammed underground from this mining complex to the Koehler portal loadout. Other breccia pipe ore bodies were also intersected by the tunnel between the portal and Carbon Lake, though the extent of workings on them is unknown.

Mine Wastes

Approximately 4,000 cubic yards of fine to coarse sulphide mine waste exists in two separate piles on site. A third pile at the site is separated from the others by the diversion ditch mentioned above. The fine grained components of the mine waste have eroded and washed from both piles directly into the stream. Runoff from these wastes has killed vegetation, allowing erosion for the natural wetlands soils.

Historic Structures

An old collapsed building exists next to the shaft and glory hole. No other structures, other than some old loadout timbers, exists on the site. There are several other shallow prospect pits only a few feet deep also on site.

Geologic Constraints to Remediation

Carbon Lake is considered as an extension of the Longfellow-Koehler site, the most geologically complex in the Mineral Creek watershed. Its position at the faulted margin of the Silverton Caldera suggests a high potential for fracture-flow groundwater-minepool interactions which

might complicate potential mine drainage remediation strategies. The extremely mineralized, faulted, brecciated nature of the site suggests a ground water component from the Carbon Lake site could be responsible for some of the metals loading seen in Mineral Creek. Surface drainage from the site has developed on and in the mineralized, brecciated faults which lie along the stream bed. These could be conducting metals laden surface runoff into the groundwater system, particularly if portions of them have been mined in the subsurface.

Suitable soils for capping mine wastes are scarce at this site. There are some thin veneers of colluvial deposits, but not enough to cap all the wastes. Soils in the vicinity of the creek may be too contaminated with metals to salvage, and are probably not suitable for revegetation without amendments.

Bedrock is generally shallow, and would be difficult to excavate. There is no suitable thickness or large enough area of unconsolidated materials in which to construct a disposal cell for the mine wastes on site. The wastes will have to be removed from the site or alternatively sterilized/stabilized insitu.

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ALSO:

PP 0378 A

BULL 0182

B 1381

PP 0535

SUMMARY OF AGREEMENT BETWEEN SUNNYSIDE GOLD CORPORATION AND WATER QUALITY CONTROL DIVISION

Sunnyside Gold Corporation's ("SGC") final reclamation plan for the Sunnyside Mine includes installation of bulkheads in the American and Terry Tunnels. These tunnels have discharge permits issued by the Colorado Water Quality Control Division ("Division"). Once valves are closed in the installed seals SGC and the Division disagree whether any seeps and springs resulting from filling the mine would be point source discharges of pollutants, subject to permits. SGC sued the Division, asking the state court to decide. In order to settle this dispute and to protect the water quality in the Animas River, SGC and the Division propose to mitigate historic water impacts and mine waste at several inactive mines in order to offset for any water quality problems attributable to seeps and springs which may result from mine closure. This settlement is reflected in a Consent Decree that will be ordered by the court.

The success of the mitigation program will be measured at the water quality reference point, in the Animas River below its confluence with Mineral Creek, downstream of Silverton (water quality monitoring station A-72). Both parties have agreed that the concentration of dissolved zinc is the indicator water quality parameter that will be used to assure water quality is protected. In order for the agreement to be successfully completed, the water quality (dissolved zinc) at A-72 will be compared statistically to baseline water quality data to determine if it has deteriorated.

SGC will first plug the American and Terry Tunnels and then begin to divert and treat water from Cement Creek at the American Tunnel treatment plant. This will create a water quality "cushion" to protect the Animas River during the mitigation work. SGC will then complete all the projects on the "A" List, which include: filling the mine with alkaline water; removal of the mine waste dump at the south fork of Cement Creek; removal of the surface tailings at the Eureka townsite; mitigation of surface mine wastes and installation of a bulkhead at the Gold Prince Mine; and mitigation at the Koehler Longfellow Mine site. After the mine pool has come into physical equilibrium and following completion of the A-list projects a period of post mitigation sampling occurs. The general agreement will have been successfully completed if a statistical analysis shows that water quality at the reference point has not deteriorated. If water quality criteria are not met, SGC can complete projects on the "B" List and other projects to remove more zinc from the system. These projects include mitigation of the Boulder Creek Mill tailings; Pride of the West tailings, closure of the Columbus Mine portal, and closure of the London Mine portal. The projects listed involving third parties will require the owners approval prior to work starting.

Once the agreement is successfully completed, SGC's discharge permits for the American and Terry Tunnels will be terminated and SGC will have no future liability in the basin for any seeps and springs that result from the portal plugging. If the agreement is prematurely terminated, SGC and the Division will return to court, and for 30 months, SGC will treat any flows from the American Tunnel and the flow of Cement Creek up to their treatment plant capacity. If the agreement is prematurely terminated and SGC discontinues treatment as a result of bankruptcy , the Division will be able to continue treatment during litigation by drawing on a financial surety provided by SGC.

During the term of the agreement, SGC will continue to be bound by its discharge permits and Mined Land Reclamation permit, including the monitoring requirements. In addition to those monitoring requirements, SGC will monitor dissolved metals, sulfate, hardness and pH at A-72, and where possible at, above and below four mitigation sites (Koehler Longfellow, Gold Prince Mine, Columbus Mine, and London Mine), three stream mouth locations (Animas River above its confluence with Cement Creek, mouth of Cement Creek, mouth of Mineral Creek) and other locations within the Animas River Basin.